AEROFAST project:
Aerocapture Guidance, Navigation and Control design

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ABSTRACT

A major issue for space exploration is directly linked to the mass budget, heavier spacecrafts with increased payloads for manned or robotic missions requiring heavier launchers. A convenient way to manage such a challenge is to perform low cost insertion techniques such as aerocapture that relies on aerodynamic forces management. Compared to a more classic aerobraking technique (performed over several months), or to a full chemical insertion (requiring a large amount of propellant), the aerocapture allows to achieve the insertion from a hyperbolic interplanetary trip into an elliptic orbit by a single and short path through the atmosphere (around 10 min) and with limited propellant needs. However, its main drawback, in addition of having never been in-flight tested, is first that it requires a fully autonomous GNC chain with a very precise navigation at entry point, then that a dedicated spacecraft able to handle large thermal and structural constraints has to be designed.

In recent years, and after the successful ARD demo-flight carried out in the late 90's, ASTRIUM Space Transportation has been involved in different aspects of the aerocapture technology within the frame of home-funded studies or ESA-sponsored programs (ATPE for instance). The AEROFAST project, granted in the frame of the seventh European Community Framework Programme (FP7), and gathering European companies under the coordination of ASTRIUM Space Transportation, covers the pre-, post- and aerocapture phases of a scientific mission around Mars. This poster presents the current status of the GNC chain designed to perform the aerocapture manoeuvre. In order to limit development risks, existing solutions developed and validated for past applications (Ariane 5 for the inertial Navigation, the ARD for the Control and ATPE for the Guidance) have been re-engineered to cope with AEROFAST mission requirements and vehicle design. Preliminary performance is established using 4 DOF Monte-Carlo simulations (GNC chain with simplified Navigation and Control performance models) as well as 6 DOF unitary runs (Control function only) to derive requirements towards the RCS.